THE DESIGN OF HANDS-ON SCIENCE LESSON PLANS FOR FOURTH GRADE

MASTER'S PROJECT

Submitted to the School of Education
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Master of Science in Education

by

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CHAPTER I

INTRODUCTION TO THE PROBLEM

Although science is an important subject, many elementary schools lack an effective science program which may increase the students' cognitive abilities. Research studies show that schools can successfully resolve this problem by implementing a science program which uses a hands-on teaching approach. Hands-on science lessons are effective since the students can discover, explore, and identify concepts by doing science activities. Students also increase their critical thinking skills and demonstrate more interest in science (Otten, Hoffman, and Stoodt, 1995). Since children naturally enjoy experimenting and observing new things, hands-on science lessons are interesting to them and provide an opportunity for teaching scientific principles.

Even though research studies show that hands-on lessons are effective, many teachers are not using this instructional approach in the classroom (Donivan, 1993). Teachers often do not have the necessary time to prepare hands-on lessons. Many elementary teachers also lack the expertise for leading these activities. In addition, teachers are reluctant to alter their teaching style since a hands-on approach is less structured.

This writer believes the study of hands-on lessons is an important study for three main reasons. First, research studies show that effective science programs use hands-on lessons. In these programs students improve their understanding of science principles

and also increase their interest in studying science. Therefore, this writer believes hands-on lessons are an excellent means for emphasizing science more in the classroom. Second, elementary teachers often lack the time and knowledge to prepare meaningful science lesson plans. This study provides teachers with effective hands-on lessons that are ready to use in the classroom and includes background information on the science principles to increase the teachers' knowledge. Third, many hands-on science lesson plans available to teachers require materials that are difficult to gather for use in the classroom. The lessons in this study were specifically developed for use with materials that are readily available. This study addresses these reasons and thereby should aid teachers in developing more effective science programs.

Statement of Purpose

The purpose of this study was to design science lesson plans for fourth grade students which utilize hands-on teaching principles.

Limitations of this Study

A. The lessons selected for this handbook were limited to activities which specifically relate to the fourth grade science curriculum.

B. The activities selected for these lesson plans were limited to materials that could be easily obtained by teachers, and the activities did not require any additional safety precautions beyond what typically exists in intermediate grade classrooms.

Definition of Terms

Cooperative learning groups are groups of three to five students who work together on an activity.

Hands-on is a teaching approach which actively involves students in a lesson.

Intermediate grades are the school grades that include fourth, fifth, and sixth grade.

Science unit is used to define a series of science lessons about the same subject.

CHAPTER II

REVIEW OF THE LITERATURE

In this chapter the writer presents a review of the related literature. It is divided into the following sections: Characteristics of Effective Science Programs, Description of the Hands-on Teaching Strategy, Description of the Evaluation Strategy, and Steps for Implementing Hands-on Science Lessons.

Characteristics of Effective Science Programs

One characteristic of an effective science program, according to Winokur (1992), is that it be composed of lessons that are developmentally appropriate and actively involve the students. Developmentally appropriate means the lessons should correspond to the needs of the child's level of thinking. Lessons that actively involve the students require them to observe and explore materials. For example, a lesson that gives the students the opportunity to explore the properties of water would make a study about rain forests more effective. The students would be actively involved and the lesson would be appropriate for their level of knowledge since they could now relate directly to the environment of a rain forest. Lessons which actively involve the students and are appropriate for their level of thinking are one characteristic of effective science programs.

In addition to this key characteristic, researchers in the study by Bredderman (1983) concluded that for science programs to be effective teachers must be concerned about three aspects of their

teaching. First, they must provide a means for the students to increase their knowledge of science content. Specifically, the lessons must be presented at a level that the students can grasp the concept and then further develop their knowledge. Second, teachers must designate a significant amount of time each day to teaching science. In order for students to improve their knowledge of science, they need time to apply the concepts. Third, teachers must continually increase their own knowledge of scientific principles. Many schools provide teachers this opportunity by offering in-service programs that help them study science concepts. All effective science teachers exhibit these aspects in their teaching.

Another team of researchers, Blumenfeld and Meece (1988), identified a characteristic of teachers that is evident in successful science programs. These teachers demonstrated a specific behavior that promoted higher level thinking skills in their students. This behavior entailed expecting and encouraging the students to participate orally during the science lessons. Furthermore, teachers continually checked the students' understanding by asking each student to explain his/her answer. Blumenfeld and Meece (1988) noted that these science teachers continued to ask questions until many or all of the students raised their hand to answer a question. As a result, every student became involved in the lesson and his/her understanding of science content was strengthened. This teacher behavior describes another key characteristic of effective science programs.

Similarly, Tobin and Fraser (1990) reported some of the same characteristics mentioned previously and some additional factors common among teachers in exemplary science programs. These

researchers noted that in each science program the principal is involved; there is a science teacher, university professor, or parent who assumes a lead role in developing the program; and the teachers have sufficient science knowledge. The teaching approach in each classroom is also similar in many ways. Teachers allow students to work in groups and give the students access to the materials they need for testing or collecting data. In addition, each teacher places little emphasis on the textbook and uses a hands-on approach that includes asking the students key questions. These factors which Tobin and Fraser (1990) specifically identified also denote necessary elements of effective science programs.

In the above section the writer reviewed the specific characteristics that researchers discovered in studying effective science programs. In the following section the writer presents a detailed description of the hands-on teaching strategy that captures these specific characteristics of effective science programs.

Description of the Hands-on Teaching Strategy

The hands-on teaching strategy is different from the traditional textbook approach because the role of the teacher and the student change. According to Rossman (1993), when teachers use a hands-on approach they are facilitators of the information for the students instead of presenters of the material. Therefore, the students' role is to seek information instead of receive information. As Donivan (1993) reported, this role requires the students to question, explore, and experiment. As a result of this change in teacher and student roles, Rossman (1993) explained there is a greater emphasis on the student's responsibility for learning and on

the teacher's approach to classroom management. The particular role of the teacher and the student define how the basic structure and purpose of the hands-on teaching strategy contrasts with the traditional textbook approach.

Mastropieri and Scruggs (1994) stated three other ways the textbook approach is different from the hands-on approach. First, when teachers instruct using a textbook approach they teach an extensive amount of content which broadly covers many areas of science. In contrast to this approach, when teachers use a hands-on teaching strategy they teach a few units but emphasize concepts within each of these units in depth. Second, teachers using a textbook approach present the content by having the students study many vocabulary words and facts while reading their textbooks, then the students recall this information for tests. Teachers using a hands-on approach do not emphasize reading assignments, but they involve the students in many science activities and assess the students' learning through performance based measures instead of tests. Third, students who learn through a textbook approach participate in a few science activities that mainly involve a paper and pencil. These activities use low level thinking skills since the students verify hypotheses that were explained in their previous readings. Students who learn from a hands-on approach do many science activities that involve a variety of materials. These activities use higher level thinking skills since the students develop their own hypothesis. These three differences outlined by Mastropieri and Scruggs (1994) explain how the textbook instructional method contrasts with the hands-on teaching strategy.

In the previous section the writer described the hands-on

teaching strategy by contrasting it with the traditional textbook approach. In the next section the writer discusses an evaluation procedure that is associated with the hands-on teaching strategy.

Description of the Evaluation Strategy

When teachers use a hands-on teaching strategy, they evaluate a type of written assignment called a product that the students complete during the science activity. The teachers design this product so that it requires the students to use higher level thinking skills by asking them to predict, test, and draw conclusions. According to Blumenfeld and Meece (1988), teachers need to carefully plan the type of product that they assign to the students. If the product is too complicated to complete, such as writing a report which requires gathering and organizing data, then the students concentrate on the product rather than engaging cognitively in the lesson. Charts and models are simpler products that can be assigned to help students gather and organize data. When the students complete the product the teacher can evaluate it and ascertain what the students learned during the lesson.

Renner and Marek (1988) recommended a specific type of evaluation product consisting of two parts. First, the teachers evaluate records that the students keep during the hands-on science activity. These records can include pictures along with sentences for explanation. Second, the teachers evaluate questions that the students answer at the end of the activity. The questions require the students to apply what they learned while doing the science activity instead of asking them to list factual information. For example, the students may be asked to explain if their hypothesis

was correct based on the results of the activity. The teachers can use this specific evaluation product to understand how well the students grasped the concepts during the science activity.

In the above section the writer described the type of evaluation procedure teachers use with the hands-on teaching strategy. In the following section the writer explains the actual steps for implementing hands-on lessons.

Steps for Implementing Hands-on Science Lessons

There are five basic steps teachers should follow when using a hands-on teaching strategy. These steps reflect the guidelines that Rossman (1993) suggests for teaching effective hands-on lessons. The first step involves preparing thoroughly for the lesson. The teachers should prepare by testing the materials ahead of time to be aware of any difficulties the students may encounter while doing the lesson. Also, the teachers should prepare by writing very clear instructions for the students. According to Blumenfeld and Meece (1988), this is a very important step because if the procedures for dealing with the materials are too complex, then the students will be less attentive to the lesson.

The second step is selecting the problem for the students to solve. The teachers develop problems for the students to solve by listening to questions from their students. Rossman (1993, p. 36) explains, "The problem should captivate students' attention, be meaningful, and allow a wide range of individual responses." The problem should also extend or reinforce the content that is being studied.

The third step is managing the classroom effectively while the

students solve the problem. The teachers should give the students independence and responsibility. Also, the teachers should make sure all the materials necessary for solving the problem are accessible to the students. The teachers need to realize and accept that there will be more noise and confusion as the students solve the problem. The teachers should stay alert and anticipate any difficulties that might arise in order to take the necessary steps to prevent them.

The fourth step is how the teacher should relate to the students while they solve the problem. Rossman (1993) recommends that the teachers respond to the students by giving guidance or feedback concerning their strategies for solving the problem. The teachers should help the students achieve success, without causing them to become dependent.

The fifth step is bringing closure to the lesson by debriefing with the students in a discussion format. The students can learn how their peers solved the problem and the teachers can also include additional content in the lesson. In addition, this final step provides an opportunity for the teachers to assess the students' level of understanding and ascertain the effectiveness of the activity. By adhering to these five steps or similar guidelines, teachers can successfully implement hands-on science lessons.

Summary

Research shows that effective science programs have similar characteristics. Teachers in each program use a hands-on teaching approach that actively involves the students in the lesson. This teaching approach is defined by the particular roles of the teachers

and students. The instructional technique of a hands-on approach also differs from a traditional textbook approach. The evaluation procedure associated with the hands-on teaching strategy involves the teacher designing an appropriate product for the students to complete. The product promotes higher level thinking for the students and it allows the teacher to ascertain what the students learned. In order for teachers to effectively implement a hands-on teaching strategy, they should follow specific steps for preparing and facilitating the lesson. Since hands-on lessons require careful planning, this writer designed a number of lesson plans to aid teachers who are interested in implementing hands-on lessons.

CHAPTER III

RESEARCH DESIGN

Procedure Used in Developing the Lessons

In order to develop effective and interesting hands-on science lesson plans this writer gathered ideas for activities to be used in the lessons from a variety of sources. Science books, teacher journals, and other resources available to teachers which contained examples of hands-on science lesson plans were examined. From these sources the writer only selected activities that could be integrated into an actual fourth grade curriculum. Each selected activity focuses on a concept or subject associated with a particular area of scientific study in fourth grade.

When the writer determined the activities for the lesson plans, she also considered the materials that were necessary for the activity and the complexity of the procedures for using the materials. The activities selected only require common materials that are readily available to teachers. Furthermore, the activities chosen only need simple instructions, allowing the students to concentrate on the activity rather than the procedures for using the materials. By selecting these types of activities the writer developed effective hands-on lessons that enhance the fourth grade science curriculum.

Critique of the Lessons

In order to measure the effectiveness of these lesson plans, this writer had the lessons critiqued by other fourth grade teacners. Each teacher reviewed the lesson plans and provided feedback on an evaluation form. (An example evaluation form is included in the appendix.) The first part of the form asked the teachers to answer six general questions concerning the effectiveness of each lesson. The second part of the form asked the teachers to provide additional comments regarding the specific strengths and weaknesses of the lessons as well as anticipated problems and recommendations for the lessons. The information gathered from the teachers was used to revise the lesson plans.

CHAPTER IV

THE RESULTS

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INTRODUCTION TO THE LESSONS

These lesson plans are designed for fourth grade teachers to use when teaching science. Each lesson actively involves the students in working with common materials to discover scientific principles. All of the lessons focus on scientific knowledge or focus on using the scientific method. The lessons focusing on scientific knowledge relate to areas of study including: matter, measurement, and the human body. The five numbered lessons that focus on using the scientific method involve solving problems or conducting simple experiments. The lessons can be selected in any order to enhance a science unit.

Most of these lessons employ cooperative learning groups. When students work together, they usually are more successful. However, they need to receive prior instruction in working together. This instruction should include teaching the students communication and organizational skills. First, the students should learn how to share their ideas and listen to other students' ideas by having the teacher model appropriate behavior in role playing situations. Second, the students should organize their groups by establishing particular responsibilities for each student. For example, one student can be responsible for getting and returning the materials, another student can ask the teacher questions when the group needs assistance, another student can monitor the group making sure each member has an opportunity to participate and that the group finishes on time, and another student can record and report any data that is

gathered. The students should also realize that they are each responsible for completing their own student recording page for each lesson. When the students understand these instructions they will gain more from the science lessons.

Each lesson includes a plan for the teacher, consisting of four parts, and recording pages for the students. The first part of the teacher plan outlines specific objectives to teach science content as well as higher level thinking. The second part gives the materials that are needed for the activity. The third part explains simple procedures for the teacher to follow, and the fourth part is an evaluation procedure for the teacher to assess the students' learning. The student recording pages include easy to follow instructions for doing the activity and questions to answer. The questions help the students to focus on the important parts of the activity and stimulate higher level thinking. The teacher lesson plan and the student recording pages provide the necessary guidelines for conducting each activity.

Area of Study: Scientific Knowledge about Matter

Lesson: Working with Solutions

Objectives:

1. The student will be able to dissolve a solid in a liquid.
2. The student will be able to explain when a solution is saturated.
3. The student will be able to predict if liquids and gases can also be dissolved in liquids.

Materials needed for each group of students:

5 small clear plastic cups
water
5 stirring sticks
measuring spoons
newspaper or plastic cloth to cover work area

Measure each of the following on to a separate lid
2 tablespoons flour
1 tablespoon sugar
1 tablespoon salt

Materials needed for the teacher:
cooking oil, milk, eye dropper,
bottle of Coke or Pepsi, balloon, shiny can, ice cubes

Procedures:

1. Before the students begin working in their individual groups, review the materials, how to measure, and the steps on the Student Recording Page. Pass out the materials and assign the students to complete the activity.

2. After the students complete the activity, lead a class discussion, asking the students to explain what they learned. Explain that when a substance dissolves in a liquid, then we say it is soluble.

3. Conclude this lesson by doing the following demonstrations for the whole class.

Ask the students if gases can be dissolved in liquids. Show the students how there is gas in soda by opening a bottle of Coke or Pepsi and placing a balloon over the neck of the bottle. Then swirl the bottle. Discuss with the class what is happening.

Ask the students if liquids could turn into a gas and then back into a liquid state again. Place some ice cubes in a shiny can and watch for water droplets to form. Discuss with the students that the ice cubes are cooling the air. Remind the students that air holds water vapor. Have them think about the example of a pot of water boiling and seeing steam as the water is changed to a gas.

4. Finally, ask the class to think of other examples of when water droplets form because the air is being cooled, and list them on the chalkboard. Some examples may include a soda can that just comes out of the refrigerator, a pitcher of ice water, and the windows on a car.

5. Collect the question pages from the students to evaluate them.

Evaluation:

To assess what the students learned read through the answers they wrote for each of the questions. Assign point values for each question. Suggested scoring guidelines are listed below.

4 points for expressing the answer clearly and showing knowledge of the concepts
3 points for showing knowledge of the concepts
2 points for showing partial knowledge of the concepts
1 point for only answering the first part of the two part questions

Student Recording Page

ACTIVITY: Working with Solutions

NAME _____

1. Describe each of the solids, flour, sugar, and salt. List ways in which they are similar. List ways in which they are different.

_____

_____

_____

2. Label three cups by writing F for flour, S for sugar, and ST for salt and measure 1 tablespoon of <u>water</u> into each cup.

3. Measure 1/4 teaspoon of flour into the water and stir with the stick until the flour dissolves. Did all the flour dissolve? Add 1/4 teaspoon more and stir again. This is now a **solution** since you are dissolving a solid in a liquid. Continue adding 1/4 teaspoon of flour until the flour will no longer dissolve. Record a tally mark each time you add a 1/4 teaspoon. When the flour will no longer dissolve it is **saturated**.

How much flour did you add before the solution was saturated? (Count your tally marks. Remember that four tally marks equal one teaspoon.) _____

Describe how the solution looks now. _____

_____

_____

4. Measure 1/4 teaspoon of sugar into the next cup and 1/4 teaspoon of salt in the last cup. Repeat the same steps you did with the flour in step 3.

Did both the sugar and the salt dissolve in the water? Write your answer below and tell how much of each solid you added until the solution was saturated.

_____

_____

_____

Describe how each solution looks now. _____

_____

_____

5. Now label the other two cups. Write milk on one and cooking oil on the other and measure 3 tablespoons of water into each cup.

6. The person assigned with the material responsibility in each group should carry these 2 cups to the teacher. The teacher will add a little milk to one cup and a little cooking oil to the other cup. Stir the liquids in each cup.

Did the milk disappear in the water? How do you know?

_____

_____

_____

Did the cooking oil disappear in the water? How do you know?

_____

_____

What other liquids would you predict to disappear in water?

_____

_____

_____

Area of Study: Scientific Knowledge about Measurement

Lesson: Using Measurement Devices

Objectives:

1. The student will be able to measure using a clock, ruler, metric stick, scale, balance, and measuring cup.
2. The student will be able to make and test a prediction.
3. The student will be able to explain why measuring is important.

Materials needed for preparing the stations:

yardstick
chalkboard and chalk
meterstick
scale
balance
clock with second hand
2 pieces of yarn that are different colors (less than a meter)
2 sets of measuring cups
2 dishpans
paper and pencil
dried beans in two different shaped containers numbered 1 and 2
apple, orange, onion, and potato
3 different objects each weighing 8-12 pounds each
signs numbered 1-5

Procedures:

1. Set up the following stations around the classroom. Place a sign on the wall to mark each station. Review the Student Recording Page to become familiar with the directions for each station.

Station #1 Draw a horizontal line on the chalkboard about 18". Draw a vertical line about 12" in length near the first line. Label the first line A and the second line B. Leave some chalk on the ledge and place the yardstick here. On the floor or on a nearby table lay out one piece of yarn in the shape of a triangle and the lay out the other piece in a straight line. Place the meterstick here.

Station #2 On a level table place the balance, apple, orange, onion, and potato.

Station #3 On a hard surface place the scale and the three objects weighing 8-12 pounds.

Station #4 At a table or desk where the clock is in view place the pencil and paper.

Station #5 Somewhere else in the room place the two containers filled with beans, the dish pans, and measuring cups.

2. Pass out the Student Recording Pages and explain the following directions for the stations to the students. Each group of students should rotate around to each station. At each station the students should predict a measurement and then test the measurement. The students should not touch the materials when making their predictions, and a different student should do the measuring each time. The materials should be placed the same way when the students leave the station as they were at the beginning. The students should rotate every 10 minutes to the next station. The students should only take their pencil and Student Recording Pages to each station.

3. Tell each group of students at which station to begin and remind the groups to rotate every 10 minutes.

4. After every group has completed each station, lead the class in a discussion. Ask the students which measurement was the hardest to predict and why. Also discuss some of the activities marked for additional time.

5. Collect the Student Recording Pages from the students and evaluate them.

Evaluation:

To assess what the students learned read through the answers they wrote for each of the questions. Assign point values for each question. Suggested scoring guidelines are listed below.

3 points for predicting and measuring correctly or for answering a question with scientific knowledge
2 points for predicting and measuring with a slight error or showing partial knowledge when answering a question
1 point for not answering completely

Student Recording Page

ACTIVITY: Using Measurement Devices

NAME _____

Station #1

Predict: Which line do you predict is longer? Circle the letter.

A or B

Test: Use the yardstick to measure each line.

Line A measures _____ inches.

Line B measures _____ inches.

Predict: Which piece of yarn is longer? Circle the shape. △ —

Test: Use the meterstick to measure each piece of yarn. Place the first piece of yarn in the shape of a triangle again when you finish.

The △ measures _____ cm.

The — measures _____ cm.

If you have additional time have one person draw a horizontal line on the chalkboard without a ruler. Now have another person try to draw a vertical line exactly the same length. Measure the length to see how close you are to the horizontal line.

Station #2

Predict: Which fruit or vegetable is the heaviest? _____

Test: Use the balance scale. Write which one is the heaviest and tell how you figured your answer.

_____

_____

_____

If you have additional time try to see if you can balance the scale using the pieces of food.

Station #3

Predict: Which object is heavier than one object but lighter than the other one? (Look carefully at the 3 objects given.)

Test: Use the scale to measure the weight of each object. Write the name of each object, and how much each object weighs in pounds. Which object is heavier than one object but lighter than the other object?

_____

_____

If you have additional time, try to find three other objects that weigh exactly 25 pounds when they are on the scale together.

Station #4

Predict: Which would take the shortest time? Circle your answer.
Saying all the letters of the alphabet
Writing all the letters of the alphabet

Test: Have one person write the alphabet neatly on the paper and have the other person time using the second hand on the clock. Also have one person say the alphabet and have another person watch the time.

_____min._____sec. for writing the alphabet
_____min._____sec. for saying the alphabet

If you have additional time predict how high you can count in one minute. Have one person count and another person time.

Station #5

Predict: How many cups of beans are in each container? Write down your predictions.
_____ cups of beans are in container #1.
_____ cups of beans are in container #2.

Test: Pour out the beans from container #1 into the dishpan. Use the measuring cups to measure how many beans. Put the beans back into the container. Also measure the beans in container #2 the same way.

_____ cups of beans are in container #1.
_____ cups of beans are in container #2.

If you have additional time guess how many beans are in 1 cup. Check your answer by counting the beans.

Conclusion:
Explain why you should always check your measurement and not just make a prediction when doing an experiment.

_____

_____

_____

Choose one of the stations. Explain how you could have made a better prediction, if you could touch the materials.

_____

_____

_____

Area of Study: Scientific Knowledge about the Human Body

Lesson: Explaining How Joints Work in the Skeletal System

Objectives:

1. The student will be able to make models of three different kinds of joints in the human body.
2. The student will be able to identify joints in the human body by observing their similarities with the models.
3. The student will be able to explain the importance of each kind of joint.

Materials needed for each group of students:

tennis ball
posterboard
masking tape
glue
tube from a roll of toilet paper
scissors
a pattern of a bone about the size of a large marking pen

Procedures:

1. Review with the students how the bones are connected in the human body. Explain to the class that they will make models of the three kinds of joints, and then figure out where these joints are located in the body.

2. Pass out the materials and the Student Recording Pages. Assign the students to complete the activity.

3. When the students complete the activity, lead a class discussion. Ask the groups to report examples in the body of each kind of joint. List the three kinds of joints on the chalkboard and below each category write all the different places where each joint is located in the body.

4. Also ask the class why it is important to have fixed joints in the skull. Identify other places where there are fixed joints that protect organs.

5. Collect the question pages from the students to evaluate them.

Evaluation:

To assess what the students learned read through the answers they wrote for each of the questions. Assign point values for each question. Suggested scoring guidelines are listed below.

3 points for showing knowledge of the concepts
2 points for showing partial knowledge of the concepts
1 point for only answering the first part of the two part questions

Student Recording Page

ACTIVITY: Explaining How Joints Work in the Skeletal System

NAME _____

1. Make a model of three different kinds of joints by following the directions.

Fixed Joint- Trace the pattern of the bone two times on the poster board. Cut out the two bone shapes. Glue the small end of one bone to the small end of the other bone. Just put a small line of glue on the very edge and hold them together for a few minutes until the glue sets. Do not glue one bone on top of the other bone. The glue represents the cartilage which holds bones together at fixed joints. When the joint is dry label the poster board, fixed joint.

Hinge Joint- Trace the bone pattern two more times on the poster board and cut out the bone shapes. Use masking tape to connect the bones together at the small end. Stretch a piece of tape from one bone across to the other bone. Do this on the top side and the bottom side. The masking tape is like one of the many ligaments which join bones together on a hinge joint. Label this piece of poster board, hinge joint.

Ball-and-Socket Joint- Tape the tube from the roll of toilet paper to the tennis ball so it is sticking straight out. Use about four pieces of masking tape to support it. The tennis ball and the tube together make one bone. While holding the tube fit the tennis ball into the palm of your hand and wrap your fingers loosely around the tennis ball. Your palm represents the socket which the bone fits into and your fingers are like the ligaments.

2. Look carefully at the fixed joint. (Do not force the bones to bend back and forth.) Does the glue hold the 2 bones tightly together? _____
Can the bones move easily in any direction? _____

Look carefully at the hinge joint. Can the 2 bones move easily?

_____
How is this joint like a hinge on a cupboard door?

_____

_____

_____

Now place the ball-and-socket joint in your hand. Hold the tube end and move it around using your other hand. In what directions can you move this ball?

_____

3. Describe how the hinge joint and the ball-and-socket joint move differently.

4. How is the fixed joint different from the hinge joint and the ball-and-socket joint?

5. Your arm is connected to your shoulder by a joint. Move your arm around. Try moving it in a complete circle. What kind of joint connects these bones? _____
How do you know?

See if you can find one other place on your body where you have this joint. What bones does it connect?

6. Your skull is made of many small bones. Do these bones move? _____
What kind of joints hold them together? _____

7. Move your fingers back and forth. What kind of joint connect the bones of your fingers? _____
What other bones are connected by this kind of joint?

8. How would your arm be different if it had a fixed joint connecting the arm bone and shoulder bone?

Area of Study: Scientific Knowledge about the Environment

Lesson: Preventing Pollution

Objectives:

1. The student will be able to predict what happens to the environment when dangerous materials are disposed of improperly.
2. The student will be able to explain how to dispose dangerous materials properly.
3. The student will be able to list dangerous materials at home that should be disposed of properly.

Materials needed for each group of students:

table knife
cup of water
stalk of celery with the leaves on it
food coloring
ruler with metric markings
paper towel

Procedures:

1. Pass out the materials and the Student Recording Pages. Assign the students to complete the activity.

2. When the students complete the questions in part 4, lead a class discussion.

3. Explain to the class that the cup of water represents the environment and the celery stalk represents a plant. Ask what represents the pollution. Ask the class how the celery or plants can be affected by pollution. Now ask the class to think of things in their trash at home which could be dangerous if not disposed of properly. Examples include old batteries, motor oil, paint, etc.

4. When the celery has been in the water for 2 hours, assign the students to complete the other questions.

5. Collect the question pages from the students to evaluate them.

Evaluation:

To assess what the students learned read through the answers they wrote for each of the questions. Assign point values for each question. Suggested scoring guidelines are listed below.

4 points for expressing the answer clearly and showing knowledge of the concepts
3 points for showing knowledge of the concepts
2 points for showing partial knowledge of the concepts
1 point for only answering the first part of the two part questions

Student Recording Page

ACTIVITY: Preventing Pollution

NAME _____

1. Put a few drops of food coloring in the cup of water to "pollute" it. Wait a few minutes. Write what happens.

_____

_____

2. Cut off the bottom of the celery about 3 cm. Look at the celery where you cut it. Describe its color and texture.

_____

_____

_____

3. Put the celery in the cup of water. Measure the water level on the outside of the cup with your ruler. Write down the water level.

_____ cm

4. Leave the celery in the water for 2 hours. Answer the questions.
What do you predict will happen to the celery?

_____

_____

What happens when chemicals from the garbage leak on to the ground?

_____

_____

_____

List all the parts of our environment that are affected when the chemicals leak.

_____

_____

5. Remove the celery and pat it dry with the paper towel. Cut another small piece off the bottom of the celery. Keep cutting off small pieces until you reach the leaves. Look at the celery each time you cut it.
What do you see? Write your answer on the next page.

6. Did the celery use any of the polluted water? _____
Explain how you know.

7. What would happen to the celery if the pollution would have been dangerous?

8. What could happen if a person or animal ate the celery?

9. How can you help prevent this type of pollution?

Area of Study: Scientific Knowledge about Geology

Lesson: Testing Soils to See the Effects of Weathering and Erosion

Objectives:

1. The student will be able to predict which soil will hold the most water.
2. The student will be able to test how much water different soils absorb.
3. The student will be able to explain which soil is best for growing plants.
4. The student will be able to draw conclusions about weathering and erosion.

Materials needed for each group of students:

samples of various soils in large paper cups
newspaper
water
cup or bowl slightly larger than paper cups
liquid measuring cup
sharp pencil

Procedures:

1. Assign the students to collect various soil samples around their house and bring each one to school in a plastic bag. Make sure that each group has a variety of kinds of samples. Some samples could include sandy soil, soil with lots of gravel, potting soil, top soil, clay soil, and garden soil. Assign each group to lay out their soils on newspaper to dry. They should also label each sample. The soils should be left in a warm dry place for about a week.

2. After the soils are thoroughly dry, review the testing procedures with the class on their Student Recording Pages. Assign each group to complete the activity sheet.

3. To conclude this lesson, lead a discussion with the students about what they learned during the activity. Ask them to consider what happens when a hillside has very sandy soil and there is a hard rain. In contrast, ask the students which soil would cause fields to flood easily. Give the students other examples for them to apply their knowledge about weathering and erosion.

4. Collect the Student Recording Pages for evaluation purposes.

Evaluation:

To assess what the students learned read through the answers they wrote for each of the questions and check for accuracy on the chart. Suggested scoring guidelines are listed below.

<u>questions</u>

3 points for writing a complete answer which expresses scientific thinking when necessary
2 points for a brief but logical response
1 point for a partial response showing little scientific thinking

<u>Chart</u>

3 points for completing the chart accurately
2 points for completing the chart with few errors
1 point for partially completing the chart or having many errors

Student Recording Page

ACTIVITY: Testing Soils to See the Effects of Weathering and Erosion

NAME _____

1. Observe each soil sample. Explain how they are alike and how they are different.

_____

_____

2. Predict which soil would soak up the most rain in a storm and which soil would not let the water drain through.

_____

_____

3. Now test your prediction. Follow these steps.

1. Label a paper cup for each soil sample.
2. Use a sharp pencil to poke holes in the bottom of each cup.
3. Fill each paper cup about 3/4 full of the soil sample.
4. Fill the measuring cup to the 1 cup line with water.
5. Hold the cup of soil over the bowl and slowly pour the water into the soil.
6. When the cup stops dripping pour the water that came through the soil back into the measuring cup.
7. On the chart write the kind of soil you tested, how much water came through the soil and figure how much water the soil absorbed.
8. Repeat steps 4 - 7 with each soil sample.

Kind of Soil sample	Amount of water poured into soil	Amount of water that came through soil	Amount of water that the soil absorbed
	1 cup		
	1 cup		
	1 cup		
	1cup		
	1 cup		
	1 cup		

4. Review what you learned from this activity.
   On the chart circle the kind of soil which held the most water.
   On the chart mark a check next to the kind of soil which held the least water.

   Which soil would be best for growing plants? Explain your answer.

_____

_____

Using the Scientific Method

Lesson #1: Designing and Testing a Container

Objectives:

1. The student will be able to use the steps of the scientific method in designing and testing a special container.
2. The student will be able to predict how selected materials can be used to protect an egg.
3. The student will be able to explain why scientists use the scientific method in designing a product.

Materials needed for each student:

2 eggs
newspaper
cardboard
ruler
tape
scissors

Procedures:

1. Assign each student to design a container for transporting an egg from a farm to a grocery store and then to a refrigerator in a home. Explain that their model will only hold one egg. Brainstorm with the students some factors they should consider when creating their container. For example, will the container be durable, will it insulate the egg to keep it cold when not refrigerated, and will it be easy for a person to carry.

2. After the class discusses different factors, explain to the class that in this activity they will be concerned with only one variable. They will need to design a container which will keep the egg from cracking. Explain to the students that they may use the given materials or other common materials to design their container. After the students have designed their container, they should test it with one of their two eggs. Assign the students to complete their recording pages.

3. In conclusion ask the students to show their container to the class. Lead a discussion about how scientists must test their designs and then make changes before their product is ready to be used in a real situation. Collect the recording pages. Assign each student to carry his/her egg home after school and bring it back to

school the following day. Write your initials on each egg to hold the students accountable for returning with the same egg.

4. On the following day allow the students to report orally on their experiences. Return their Student Recording Pages and assign the final question.

5. Collect the Student Recording Pages to evaluate the students.

Evaluation:

To assess what the students learned read through the responses they recorded for each part of the scientific method. Assign point values for each response. Suggested scoring guidelines are listed below.

3 points for writing a complete answer which expresses scientific thinking when necessary
2 points for a brief but logical answer
1 point for a partial answer showing little scientific thinking

Student Recording Page

ACTIVITY: Using the Scientific Method to Design and Test a Container

NAME _____

PURPOSE: What do you need to design?_____

_____

HYPOTHESIS: Write an educated guess about how the materials will protect the egg.

_____

_____

MATERIALS: List the materials you will use. _____

_____

PROCEDURE: Write the steps you will follow for designing and testing your container.

_____

_____

_____

_____

OBSERVATIONS: What did you observe when you tested your container?

_____

_____

_____

_____

CONCLUSION: What did you learn in designing your container?

_____

_____

Why is it important to test your container?

_____

_____

Day 2

After testing your container for a whole day, what changes would you make to improve your container?

_____

_____

_____

Using the Scientific Method

Lesson #2: Identifying Materials by Sound

Objectives:

1. The student will be able to use the steps of the scientific method to complete this activity.
2. The student will be able to predict the material that is making the sound.
3. The student will be able to identify properties about the materials which caused the different sounds.

Materials needed for each group of students:

5 empty film containers each filled with a different material and taped closed. All the containers for one group should have an A on top and all the containers for another group a B on top and likewise for the other groups. Use 1 Tablespoon of the following to fill the containers: rice, sand, sugar, popcorn, and an ice cube made from 1 Tablespoon of water.

Materials which the students may also choose to use during the activity:

balance scale
marker
tape
measuring spoons
paper cups
open containers filled with the following extra materials for the students to observe: salt, sugar, flour, powdered jello, rice, sand, popcorn, beads, birdseed, and sawdust

Procedures:

1. Assign the students to observe using their sense of sound what is in each container. Explain the following information to the students and write it on the chalkboard.

All the containers have 1 Tablespoon of a different material which is common to each of you. Here are some possible ideas of what is in four of the containers: salt, sugar, flour, powdered jello, rice, sand, popcorn, beads, birdseed, or sawdust. One container is a mystery, but it also has 1 tablespoon of a material which is common to you.

2. Pass out the Student Recording Pages for Day 1 and the containers. Assign the students to complete the activity.

3. On the following day pass out the containers again. Assign the students to briefly observe the materials in the containers one more time and for each group to record on the board what they

believe is in each container. The students should also mark any changes in their predictions on their recording page for Day 1.

4. Collect the papers from Day 1 and pass out the Student Recording Pages for Day 2 while the students carefully open the containers. Assign the students the Day 2 pages to complete.

5. Lead the class in discussing the different strategies each group used in making their predictions. Also, discuss why the scientific method works well with this activity. In addition to these two points discuss the mystery container and how it changed from one state of matter to another.

6. Collect the Student Recording Pages to evaluate the students.

Evaluation:

To assess what the students learned read through the responses they recorded for each part of the scientific method. Assign point values for each response. Suggested scoring guidelines are listed below.

3 points for writing a complete answer which expresses scientific thinking when necessary
2 points for a brief but logical answer
1 point for a partial answer showing little scientific thinking

Student Recording Page

ACTIVITY: Using the Scientific Method to Identify Materials by Sound

Day 1

NAME _____

PURPOSE: What do you want to find out? _____

_____

MATERIALS: List the materials you will need in addition to the containers to predict what is inside._____

_____

PROCEDURES: Write the steps you will follow for predicting what is in each container.

_____

_____

_____

_____

HYPOTHESIS: Predict what is in each container. Make a table to list your predictions.

OBSERVATIONS: What did you observe when you followed your procedures for predicting what was in each container?

_____

_____

_____

Student Recording Page

Day 2

NAME _____

CONCLUSIONS:
Which container was the most difficult to identify and why?

_____

_____

What would you do differently the next time to predict what the material is in each container?

_____

_____

Why did the rice sound different from the sand?

_____

_____

Using the Scientific Method

Lesson #3: Germinating Seeds

Objectives:

1. The student will be able to use the scientific method to complete this activity.
2. The student will be able to set up a terrarium for growing seeds.
3. The student will be able to measure, record, and graph the growth of the seeds.
4. The student will be able to draw conclusions about how the depth at which the seed is planted affects its growth.

Materials needed for each group of students:

an aquarium or similar large wide-mouth container that is clear
large stones
sand or gravel
potting soil
bean seeds (approx. 8)
water
wax pencil
black construction paper
tape
rulers with metric markings
watering can

Procedures:

Demonstrate how to build a terrarium before each group begins to set up their own terrariums. Also, review how to read the measurements in metric. Write the layers on the chalkboard as you add them to the aquarium. First, place a layer of large stones in the bottom about 3 cm deep. Second, add about 3 cm of sand or gravel. Discuss with the students how the bottom layers allow the water to drain and keep the seeds from rotting. Third, add about 20 cm of potting soil. Now plant the seeds at different depths at the edge of the aquarium so you can see the seeds when looking through the sides. Place two seeds on the surface, then plant two more seeds 2 cm deep, then put two more seeds about 5 cm deep, and plant the last two seeds about 10 cm deep. Label the various depths on the outside of the aquarium with a wax pencil. Also number each seed. Cover the outside of the aquarium by taping the black paper around the sides. Use just a little tape so you can peek at the

seeds each day. Water the soil and continue to add water occasionally to keep the soil wet. Plan to allow the seeds to germinate and then grow for approximately four weeks. Keep the terrarium in a warm place.

Explain to the students where the materials are located and the directions for cleaning up. When the students are finished setting up their terrariums they should complete the purpose, hypothesis, materials, and procedure sections of their recording pages.

Procedures for day two and following days:

Assign the students to complete the observation section of their recording pages. Each day ask a different group to report to the class the observations they made today. As a final activity assign the conclusion section of the Student Recording Pages. Collect the graph, measurement chart, and the Student Recording Pages for evaluating at this time.

Evaluation:

To assess what the students learned read through the responses they recorded for each part of the scientific method. Also check their chart and graph for accuracy. Suggested scoring guidelines are listed below.

Scientific Method Responses
3 points for writing a complete answer which expresses scientific thinking when necessary
2 points for a brief but logical response
1 point for a partial response showing little scientific thinking

Measurement Chart
4 points for recording measurements daily which appear to be accurate
3 points for recording measurements daily which show a slight error
2 points for missing some measurements and showing some error
1 points for recording measurements on less than one half of the days

Graph
4 points for writing a title, labeling both axes completely and accurately, graphing the points accurately, and connecting the points with a line
3 points for writing a title, labeling both axes and graphing the points with a slight error, and for connecting the points with a line
2 points for partial completion of the graph or some errors in graphing the measurements
1 point for little completion of the graph or many errors in graphing the measurements

Student Recording Page

ACTIVITY: Using the Scientific Method for Germinating Seeds

NAME _____

PURPOSE: What will you determine about germinating seeds?

_____

_____

HYPOTHESIS: Which seed do you predict will germinate the quickest? Why?

_____

_____

_____

MATERIALS: What materials will you need to measure the seeds?

_____

_____

PROCEDURES: Describe how you will measure and write what changes you will look for each day.

_____

_____

_____

_____

OBSERVATIONS:

1. On the following lines write any changes you notice in the seeds. Make sure you include the number of the seed. Write the date first and then write about the changes. Each day begin by writing the date on a new line.
2. Measure each seed and record its size on the chart. Watch for when the seed's root and stem begins to appear. Once the stem begins to grow measure the stem instead of the seed. On the day you first measure the stem put a circle around your measurement. This way you can remember which day you began measuring the stem.

_____

_____

_____

_____

_____

SEED MEASUREMENT CHART

NAME ______________________________

Date	seed #1	seed #2	seed #3	seed #4	seed #5	seed #6	seed #7	seed #8

CONCLUSIONS:

1. Why did you need to put the black paper around the outside of the aquarium?

2. Did the seeds at the depth you predicted germinate the quickest? Explain why or why not.

3. Which seeds germinated the slowest? Why do you think they germinated slower?

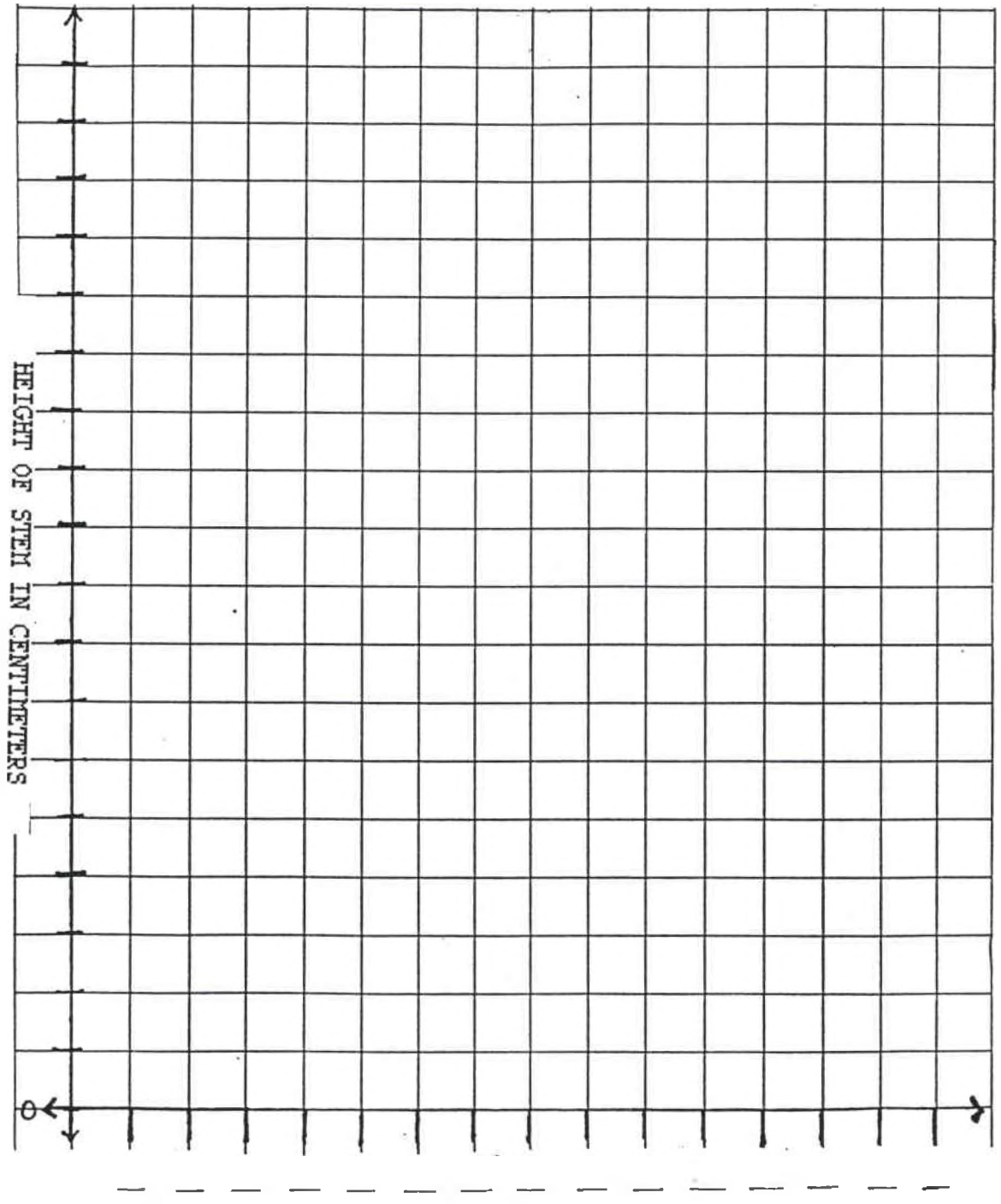
4. Which seed do you predict will grow to be the most healthy plant? Why?

<u>After three to four weeks</u>

Use the measurements you collected to draw a line graph. Decide which seed's measurements you would like to graph. Choose a seed that has grown a lot since you began your testing. Make sure you write a title for your graph and finish labeling the horizontal axes. Decide if each block will be equal to 1 cm or 2 cm and mark the vertical axes. The first measurement you graph will be when your stem began to grow. Write the date below the axes and graph the measurement. After graphing all the measurements draw a line to connect each of the points.

NAME _____

_____



DATE OF STEM MEASUREMENT

Using the Scientific Method

Lesson #4: Observing Why Objects Float

Objectives:

1. The student will be able to use the steps of the scientific method in determining why some objects float and others do not float.
2. The student will be able to predict when objects will float.
3. The student will be able to explain how an object's weight and volume affect how well it will float.

Materials needed for each group of students:

small block of wood
small piece of new aluminum foil folded into a flat square
clay
steel washers
large pan of warm water

Materials needed for the class discussion:

empty milk jug with the lid on it
milk jug filled with sand, gravel, or dirt with the lid on it

Procedures:

1. While holding up each object (the wood, foil, and clay), ask the students to raise their hands if they think the object will float. Count and record on the chalkboard how many students believe the block of wood will float, then how many believe the lump of clay will float, and how many believe the square piece of foil will float.

2. Assign the students to make a boat using wood, clay, or foil to hold some cargo or steel washers. Explain to the students that they may change the objects physical shape (except the wood). Tell the students to observe which object will hold the most cargo.

3. Pass out the Student Recording Pages and assign the students to complete the activity.

4. When each group is finished, lead a discussion. Ask each group to report how they made their boat.

5. Ask the students to explain why a canoe floats as well as a barge but a rock does not float. Discuss with the students the concept of density. Hold up an empty milk jug and ask the students if it will float. Now hold up the milk jug filled with sand, gravel, or dirt. Ask the students if this jug will float. Explain

to the class that an object sinks when it weighs more than the amount of water it displaces.

7. Collect the Student Recording Pages to evaluate the students.

Evaluation:

To assess what the students learned read through the responses they recorded for each part of the scientific method. Assign point values for each response. Suggested scoring guidelines are listed below.

3 points for writing a complete answer which expresses scientific thinking when necessary
2 points for a brief but logical answer
1 point for a partial answer showing little scientific thinking

Student Recording Page

ACTIVITY: Using the Scientific Method to Observe When Objects Float

NAME _____

PURPOSE: What do you need to design?_____

_____

HYPOTHESIS: Write a prediction about which object will hold the most cargo.

_____

_____

MATERIALS: List the materials you will use._____

_____

PROCEDURE: Write the steps you will follow for testing your prediction.

_____

_____

_____

_____

OBSERVATIONS: How much cargo did each object hold? What other things did you observe about the wood, clay, and foil?

_____

_____

_____

_____

CONCLUSION: Which object held the most cargo? Why do you think this object was a better boat?

_____

_____

Using the Scientific Method

Lesson #5: Observing the Color Spectrum

Objectives:

1. The student will be able to use the steps of the scientific method.
2. The student will be able to predict when light bends to show the colors of the spectrum.
3. The student will be able to explain why he/she has seen rainbows in other places.

Materials needed for each group of students:

mirror
paper towel
black construction paper
shallow dish with water
flashlight
crayons or markers
clear glass filled almost full of water
sunny window
prism (1 for the entire class)

Procedures:

1. Hang the prism near a sunny window so the students can see the color spectrum. Ask the students to think about why they can see a rainbow or the color spectrum.

2. Assign the students to find out what causes rainbows. Pass out the materials and the Student Recording Pages. Assign the students to try and make a rainbow form using the materials.

3. Some of the students may need assistance. Guide them by experimenting with the mirror by reflecting off the glass on to the ceiling, and then putting the mirror in the water. Light needs to pass through a clear material like water or glass with a certain angle to create a spectrum.

4. When the students are finished with their recording pages, lead a discussion. Ask each group to report their procedure for making a rainbow appear.

5. Explain to the students that the light is bending or refracting when it passes through something clear. The light is bending and spreading out to form the color spectrum. Sunlight and white light are made of all colors.

6. Ask the students if the flashlight can be used to make a color spectrum. Explain that a narrow band of light is needed.

7. Ask the students to brainstorm other places they have seen rainbows. List examples on the chalkboard and discuss why the rainbow was visible. For example, the students may have seen a rainbow from a spot of oil on a wet driveway at their homes.

8. Collect the Student Recording Pages to evaluate the students.

Evaluation:

To assess what the students learned read through the responses they recorded for each part of the scientific method. Assign point values for each response. Suggested scoring guidelines are listed below.

3 points for writing a complete answer which expresses scientific thinking when necessary
2 points for a brief but logical answer
1 point for a partial answer showing little scientific thinking

Student Recording Page

ACTIVITY: Using the Scientific Method to Observe the Color Spectrum

NAME _____

PURPOSE: What do you want to find out about rainbows?

HYPOTHESIS: Write a prediction telling when you can see rainbows.

MATERIALS: List the materials you will use. _____

PROCEDURE: Write the steps you will follow for trying to make a rainbow appear.

OBSERVATIONS: Write what you observed and draw a picture of the rainbow that formed at the bottom of the page.

CONCLUSION: Think about what you observed. When do you think rainbows appear?

RESOURCES FOR TEACHERS

There are three education journals that are particularly helpful for teachers to browse through in order to gain ideas for hands-on science activities. These journals include Learning, Science and Children, and Teaching K-8.

Also, the National Science Foundation has produced a series of television programs relating to various science topics that are aired on public broadcasting stations. The name of the television program is Bill Nye the Science Guy. As part of each program, Bill Nye or students demonstrate a few science activities that are easy to complete at home or in the classroom.

In addition to these resources, the following books contain many hands-on science activities for intermediate students.

Bochinski, J. B., (1996). The Complete Handbook of Science Fair Projects. New York: John Wiley & Sons, Inc.

Cobb, V., (1994). Science Experiments You Can Eat. New York: Harper Trophy.

Fredericks, A. D., (1996). Exploring the Rainforest. Golden, CO: Fulcrum Publishing.

Gardner, R., (1992). Robert Gardner's Favorite Science Experiments. New York: Franklin Watts.

Unwin, M., (1994). Science with Plants. London: Usborne Publishing.

Walpole, B., (1988). 175 Science Experiments to Amuse and Amaze Your Friends. New York: Random House Publishing.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Many elementary schools are interested in improving their science program. In order to help elementary teachers, the writer designed science lessons that use hands-on teaching principles. Research indicates that teachers who use a hands-on teaching strategy are very effective in teaching science. This strategy helps the students increase their science knowledge because they are actively involved with materials and solve problems. However, this strategy requires additional planning for teachers, since the students are more involved in the learning process. The writer developed lesson plans by gathering ideas from science books, journals, and other fourth grade teachers.

While designing the lessons the writer selected activities that would reflect the students' and the teachers' needs. First, the lesson plans actively involve the students in interesting activities that increase their science knowledge and develop higher level thinking skills. Second, the lessons teach the students about a particular area of study that is part of the fourth grade science curriculum. Third, the lesson plans use materials that are readily available to the teachers. As a result of these considerations, the lesson plans can be used to increase the effectiveness of science programs.

Conclusions

Using hands-on lessons effectively in the classroom requires some adaptations for most teachers. Since the students are more involved in the learning process, there is more noise and confusion in the classroom. Also, the teachers must carefully plan ahead by organizing materials and by preparing an evaluation product. This teaching strategy requires practice like any other teaching method in order for it to be effective. Many teachers who have adapted their science programs to include hands-on lessons are encouraged to continue using this strategy, since the students are more stimulated to learn science and their scientific knowledge increases.

Recommendations

The writer recommends that teachers use hands-on lessons when teaching many of the concepts in the fourth grade science curriculum. The lesson plans in this study should be used for science lessons in the classroom and as a model for developing other hands-on lessons. The writer recommends that the teacher use the textbook or another resource when teaching areas of science that would be difficult to implement with hands-on lessons. Hands-on lessons significantly enhance the students' ability to learn scientific principles as well as helping them understand the scientific method.

APPENDIX

Form for Evaluating Lesson Plans

In Part I please mark the response that you believe is most appropriate for this lesson. In Part II please consider the questions and write your comments below or directly on the lesson plans.

Name of the Lesson: _____

Part I.

1. The lesson plan will effectively teach the science concepts listed in the objectives to the students.

strongly agree agree disagree strongly disagree

2. The lesson plan will increase the students' interest level in science.

strongly agree agree disagree strongly disagree

3. The lesson plan will develop higher level thinking skills in the students.

strongly agree agree disagree strongly disagree

4. The lesson plan uses materials that will be easy to gather.

strongly agree agree disagree strongly disagree

5. The students will be able to complete the activities with little additional assistance.

strongly agree agree disagree strongly disagree

6. The evaluation procedure will effectively assess the students' learning.

strongly agree agree disagree strongly disagree

On the back please write any additional comments.

Part II.

What are the major strengths and weaknesses of this lesson plan?

What problems do you anticipate with this lesson?

What recommendations would you make to improve this lesson?

REFERENCES

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Bredderman, T. (1983). Effects of activity-based elementary science on student outcomes: a quantitative synthesis. Review of Educational Research, 53(4), 499-518.

Donivan, M. (1993). A dynamic duo takes on science. Science and Children, 31(2), 29-32.

Mastropieri, M. A., & Scruggs, T. E. (1994). Text versus hands-on science curriculum. Remedial and Special Education, 15(2), 72-85.

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